4
EVALUATION OF EXISTING RAPID SCREENING PROCEDURES

This section evaluates the previously discussed RSPs and studies according to several broad categories. Because each method/study reviewed was unique in some aspects, the following broad categories within which to compare and comment on the detailed aspects were defined:

- Organizational
- Structural
- Configuration
- Site and Non-structural
- Personnel

These five broad categories were selected as being of greatest interest to one or several segments of the target audience. To facilitate comparison, a tabular format has been used. Within each category specific items were noted, as were whether a specific RSP method or study addressed this issue, employed this data item, or simply noted this item. Where an entry is blank, no information was available.

Organizational—Refers to the general aspects of an RSP method or study that would be of interest to a person or organization implementing and managing a survey of a community. These include items such as the size of the survey defined by number of buildings, population and/or area; the types of buildings that were targeted; and whether graphic methods (sketches or photos) were used to record data.

Structural—Refers to structure-specific data items that would be of most interest and use to a structural engineer (e.g., age, structural material).

Configuration —Includes items such as whether an RSP method or study specifically noted soft stories or irregular building configuration. This would be of interest and use to architects and engineers.

Site and Non-Structural—Includes items related to the site (e.g., soil conditions, potential for pounding), and to the non-structural aspects of a building that may either pose a hazard (e.g., parapets) or may affect structural behavior (e.g., infill walls).

Personnel—Addresses two aspects regarding the qualifications of the personnel who would employ the specific RSP or study being evaluated: (1) What were the backgrounds or qualifications of the personnel who conducted the study or for whom the method was intended? (2) Could the method be applied by each or any segment of the target audience?

After reviewing all the existing surveys and available data, it becomes clear that there is currently relatively little statistical information relating damage to all types of structures under different levels of earthquake loading. Although general statements about the behavior of buildings in earthquakes can be made, it is difficult to quantify the damage. Even general statements about vulnerability based on building type are subject to question because so many other aspects such as configuration, connection detailing or local site conditions can contribute to poor structural performance. Reitherman (1985) noted that architectural configuration can be quite different from structural configuration and thus can be very misleading without access to structural drawings. Structural detailing, which can be so critical to good performance, is difficult to "score" from purely visual inspections. For these reasons, the results of an RSP cannot be regarded as definitive, and structural adequacy or lack thereof can only be determined on the basis of detailed examination by a registered professional engineer.

4.1 Organizational Aspects

Table 1 presents the evaluation of the organizational aspects of the various methods/studies. Specific items considered are discussed below.

Building Groups Targeted: Most methods or studies begin by eliminating some building types as non-hazardous (e.g., wood-frame construction), and limiting themselves to simply identifying that building type considered "most hazardous" (e.g., URM), or they have a well-defined list of structural types in their evaluation methodology. This report identifies those building types that were addressed.

Survey Area: In the case of studies where buildings in a community were actually screened, some measure of the size of the project, such as number of buildings, area, population, or other measure, is indicated.

Number of Hazardous Buildings Identified: As above, where available, the number of hazardous buildings actually identified for the particular study is indicated.

Method: A brief description of whether the method/study (i) simply employed a pass/fail measure (e.g., is or is not URM), or (ii) employed subjective measures and techniques (e.g., has a soft story, is irregular) without quantifying these items, or (iii) employed numerical scoring schemes and algorithms for combining information to arrive at a quantified measure (e.g., tension-only bracing or long-span diaphragms are given weights and these are "scored" in some fashion).

Supplemental Information Employed: Was non-visual off-site information employed, such as from building department, assessor files, Sanborn maps, or previous studies?

Explicit Earthquake Definition: Was the "earthquake loading" explicitly defined? Many times a method/study determined that buildings were seismically hazardous without clearly defining what ground motions the building was being compared against. Admittedly, for a specific jurisdiction this might be implicitly clear (e.g., a repeat of the 1906 event for San Francisco), but this aspect would need clear definition for any general RSP.

Sketch or Photo: Sketches or photos as an integral part of the data recording are invaluable for later reference. Requiring sketches assures that the survey personnel methodically observe the building.

4.2 Structural Aspects

Table 2 presents an evaluation of the methods/studies for the structural aspects. Specific items considered are discussed below.

Age/Design Level/Building Practice: Building age is usually an explicit indicator of the design level or the code under which the building was designed, and the building practices prevalent at the time of construction.

State of Repair: Maintenance and general conditions are important aspects of structural adequacy since corrosion and deterioration decreases structural capacity.

Occupancy Factor Definition: Occupancy is not an explicit factor in structural adequacy, but is important in setting priorities.

Material Groups: Broad structural material groupings can be noted in a variety of ways, and are a basic measure of seismic capacity.

Number of Stories/Dimensions: Number of stories and/or the plan or other dimensions are a broad indicator of structural dynamic properties, as well as of value.

Symmetrical Lateral Force Resisting System: The degree of symmetry of the lateral force resisting systems (LFRS) is an important clue as to adequacy of load path. If this was an item of interest to the survey team, what guidelines were they given for identifying the LFRS? If noted, how was the degree of symmetry employed?

Member Proportions: Were these noted in any way? Relatively thin member proportions are a general indication of potential problems in connections and/or member stability and, for concrete members, usually indicate non-ductile detailing.

Sudden Changes in Member Dimensions: Drastic changes in column dimensions can sometimes be observed through windows, and would indicate upper story "softness." Were these noted?

Tension-only Bracing: Was this relatively non-ductile behaving system identified as an item to note if observed?

Connections Noted: Was any attention paid to connections, as for example whether special wall/diaphragm ties were present in bearing-wall systems (e.g., tilt-up, URM)?

Previous Earthquake Damage: In areas where previous earthquakes might have weakened a building, was any attempt made to look for indications of this damage?

Renovated: Was there any indication that the building had been renovated, either with regard to architectural (thus obscuring the age) or structural details?

4.3 Configuration Aspects

Table 3 presents an evaluation of the methods/studies for the configuration aspects. Specific items considered are discussed below.

Soft Story: Abrupt changes and/or decrease in stiffness in lower stories of a building lead to large story drifts that cannot be accommodated. Was this consideration incorporated into the determination of seismic hazard, or was it noted by survey personnel but not used? Similarly, were plan irregularity, vertical irregularity, excessive openings and aspect ratio of the building or its components (vertical or horizontal) considered?

Corner Building: Buildings on corners typically have potential torsional problems due to adjacency of two relatively infilled back walls, and two relatively open street facades.

4.4 Site and Non-structural Aspects

Table 4 presents an evaluation of the methods/studies for the site and non-structural aspects. Specific items considered are discussed below.

Site-Related: So-called "adjacency" problems of pounding and/or the potential for a neighboring building to collapse onto the subject building are important structural hazards. These are two aspects that can be easily observed from the street and that the 1985 Mexico City experience again emphasized as critical. These were placed under site-related rather than structural or configuration because they involve aspects that are more related to the site and adjacent buildings than to the subject building per se.

Soil conditions or potential for seismic hazards other than shaking, such as landslide or liquefaction, are also very significant factors related as much to the site as to the structure. Admittedly, these non-shaking hazards may more easily be defined on the basis of reference maps than in the field, but in the methods reviewed were these given any consideration at all? Were soft soil/tall building or stiff site/stiff building correlations attempted as a crude measure of resonance/long period potential?

Non-Structural: Were major infill walls and/or interior partitions and their potential effects on structural behavior, especially in light buildings, noted? Were the special and relatively obvious seismic hazards of cornices, parapets, chimneys and other overhanging projections noted?

4.5 Personnel Aspects

Table 5 presents an evaluation of the methods/studies for the personnel aspects. For most projects, cost information was difficult to obtain and was usually based on criteria that are not easily compared. Some data provided included clerical and report production costs, others only the costs of survey personnel. This report provides personnel time per building reported for a particular RSP. By multiplying by labor cost, and including other expenses such as transportation and report production costs, the reader can estimate what a particular RSP would cost if applied to a particular community. Whether or not the particular RSP is appropriate for use by each segment of our target audience is indicated (by Y or N).

4.6 State of the Practice

Information provided by about a dozen practicing structural engineering firms, mostly in California, indicates that no rapid visual screening procedure is currently being used by practitioners. Typically, structural engineers have used visual screening procedures as a preliminary phase of a more detailed analysis. However, because most of the procedures involved entrance into buildings and detailed inventories of structural elements and non-structural elements, these procedures do not fit the definition of "rapid visual screening" utilized herein.

"Subjective judgment" is the type of criteria used most extensively to classify seismically hazardous buildings; in only a few cases have quantitative criteria been developed. However, in most cases, studies have been for planning purposes, and engineers have tried to include some qualitative indicator of the degree of hazard of the building to assist in setting priorities for mitigation procedures. In general, the surveys have been performed by experienced engineers or by entry-level engineers accompanied by a more experienced engineer. Most often, junior personnel have been given brief training as to what to look for and a checklist or data collection form, usually without detailed written guidelines. In some cases, a trial run through a building with the data collection forms was performed under the supervision of an experienced engineer. Usually there were no structured guidelines for identifying a building as one structural type or another, nor was there any consistent way to incorporate the uncertainty in the judgments that were made. Consequently, the variability in backgrounds and experience of the personnel and the lack of detailed guidelines can result in widely differing interpretations of the criteria for identifying hazardous buildings and hence produce inconsistent results.

4.7 Conclusions

The foregoing review indicates that no currently available RSP method or study addresses all of the major aspects fundamental to seismic hazard, and further that no really satisfactory RSP method or procedure exists. Most omit many of the described aspects, and/or are very subjective in their treatment of the data recorded. In many cases, too much reliance is placed on the experience of the survey personnel, with little attention paid to consistency among different personnel. Further, although the personnel may have been given some coaching or training in what to look for, this was usually unsystematic and omitted major aspects.

Most of the rapid visual screening procedures that were reviewed were developed for a particular municipality and thus were applied in only one geographic region. None addresses the issues of regional differences in construction practices and building code regulations. The multihazard study (Reitherman et al., 1984), NBS 61 (Culver et al., 1975) and the Navy Rapid Seismic Analysis Procedure are designed for nationwide application, but these procedures do not specifically discuss differences in building performance that might result from regional engineering and construction practices. In addition, they involve entrance into the building or calculations and thus are too detailed for an RSP.

From the studies that were reviewed and from experience with earthquake-related damage, a set of attributes of a satisfactory RSP method was developed:

1. The earthquake loading against which the building's capacity is being judged should be explicitly defined, preferably in physically based units (e.g., acceleration). The anticipated earthquake loading is defined in several of the studies such as NBS 61, the Stanford Project, the University of California Study, the OSA Hospital Survey, the New Madrid Study and the Multihazard Survey; however, non-physical units such as UBC zone or MMI are used. Only in Wiggins and Moran (1971), and Wiggins and Taylor (1986) is the use of maximum expected bedrock acceleration discussed. Because the decision of what ground motion a building should satisfactorily withstand involves not only geotechnical and seismological issues but also difficult questions of acceptable risk, the "acceptable earthquake" may often be decided in an iterative fashion. Thus, sufficient building-specific data should be clearly recorded to permit later calculations for the purposes of re-screening, given a different "earthquake loading."
2. As much as possible, supplemental information compiled from building department and assessor's files, Sanborn maps and other sources should be collated and taken into the field in a usable format, such as computer listings or peel-off labels that can be affixed to the survey form, for verification as well as aiding the field personnel. Most of the methods that were reviewed use other sources of information to supplement the visually obtained data.
3. An RSP should have the capability to survey and identify hazardous buildings of all types. In some cases, jurisdictions may wish to use the RSP in a limited form for certain "high hazard" target buildings or areas. However, all building groups should receive at least an initial limited-sample-area test screening to verify assumptions of which building type is the most hazardous within the local building stock. If these assumptions are verified, then selected building groups/areas may be targeted for reasons of economy. However, the situation of having identified all URM buildings, and having no idea of the seismic hazards in the older non-ductile reinforced concrete building group, for example, or the older unbolted house-over-garage (HOG) building group, should be avoided.
4. A quantitative approach, as exemplified in the Long Beach study (Wiggins and Moran, 1971) or NBS61 (Culver et al., 1975), appears preferable, as it not only permits pass/fail decisions, but also allows prioritization within the "failed" category. However, the quantitative "scoring" should not be arbitrary but rather should be rationally based, as far as possible.
5. Sketches should be an integral part of the data recording to assure that the survey personnel methodically observe the building. Sketches and photos are invaluable for later reference, and ideally both should be part of the field data

recording because they are complementary. Several of the reviewed methods omitted a sketch or photo.

6. Age should be explicitly recorded. Although often unavailable, age can be estimated, usually to within a decade or two, on the basis of architectural style, and thus can indicate whether a building is pre or post a specific "benchmark" year in the development of that building type. For example, in San Francisco, wood-frame buildings were required to be bolted to their foundations only since 1948. If a wood-frame building is pre-1948, it is likely to be unbolted. Similarly, unreinforced masonry was not permitted after the adoption of the 1948 building code. Thus, in a survey of hazardous buildings in San Francisco, only pre-1950 buildings were considered. These benchmark years differ by jurisdiction, but are usually locally known or can be determined and should be included in training material for survey personnel.

7. State of repair should be explicitly noted, as it forces the survey personnel to look for cracks, rot, corrosion and lack of maintenance. Although the state of repair was noted in many of the methods reviewed, it was not formally used in identifying the seismically hazardous buildings.

8. Occupancy (use) and number of occupants should be noted, using standardized occupancy categories. In the Los Angeles and Long Beach studies, occupancy was used to prioritize buildings for hazard abatement.

9. Specific observable details of structural members, structural hazards and foundation and site conditions should be itemized in a check-off format, to avoid omission.

10. Configuration issues should similarly be considered, but their contribution to seismic hazard must be quantified, at least on a weighting basis. Although some of the methods, such as NBS 61, have addressed configuration problems the scoring systems are subjective and are not based on actual damage-related data.

11. Site aspects of pounding, corner building and adjacencies, and non-structural aspects, need to be similarly noted. Few of the methods have used pounding, corner buildings, or adjacencies as criteria for identifying hazardous buildings, although these problems were noted. Several studies (e.g., City of Redlands, Multihazard Survey, NBS 61) consider non-structural hazards explicitly as part of their criteria.

12. Personnel should have adequate background and training to understand the earthquake behavior of buildings because many of the data they will be called upon to record will involve subjective decisions. In addition, the survey should be accompanied by detailed guidelines as to what to look for and how to interpret and indicate uncertain data to avoid inconsistencies in the data collection. The guidelines presented in the Multihazard Survey are useful examples.

13. Data recording should be complete and systematic. A field remote-entry electronic format (i.e., a "laptop" computer) should be considered, although for economic reasons a clipboard has many advantages.

14. Because information is often lacking, uncertainty considerations must be incorporated into the methodology, although it can be relatively "invisible." For example, building type may be

indicated as (circle as appropriate):

RCMRF*:	definite	likely	possible	unlikely
RCSW:	definite	likely	possible	unlikely
URM:	definite	likely	possible	unlikely

with weights assigned to each, on the basis of their "contribution" to seismic hazard. If it is likely that the building is an RCSW but possible that it is a URM, then the weighting would result in a higher seismic hazard than if the survey personnel were called upon to provide only one typing. The weighting and arithmetic do not need to be performed in the field, although it may be advantageous to have the weighting known to the field personnel.

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*RCMRF: Reinforced concrete moment-resisting frame
RCSW: Reinforced concrete shear wall
URM: Unreinforced masonry

Table 1
ORGANIZATIONAL ASPECTS

PROCEDURE/ Source	Building Groups Targeted	Survey Area (Size, number of buildings, population)	Number of Hazardous Buildings Identified	Method: Pass/Fail, Subjective, Quantitative?	Supplemental Information Employed?	Explicit Earthquake Definition	Sketch or Photo?
CITY OF REDLANDS/ Mel Green & Assoc. (1986)	Bearing wall URM	Test survey approximately 200 buildings	Appoximately 160 buildings	Quantitative	Aerial photo Sanborn maps	N	Y
SAN FRANCISO/ Frank Lew	URM pre-1950 construction	Entire city, population 700,000	2100 from initial 6000	Pass/Fail	Assessors' files, Sanborn maps, Parapet Safety Program files, owner feedback	N	N
ABAG/ J. Perkins et al. (1986)	WF, URM, RM, LM, TU, MH	6,000 square miles, population 5.5 million	4700-5700	Subjective	Sanborn maps, Land use maps, interviews with local building office, previous studies	N	N
STANFORD PROJECT/ JABEEC TR 81, Thurston et al. (1986)	All 27 defined classes	Phase I Entire city population 50,000	Phase I 4 sub-areas of city identified as most hazardous	Subjective and Quantitative	Palo Alto Comprehensive Plan Building Department input	MMI	Y, sketch
LOW-RISE/ Wiggins and Taylor (1986)	low rise	N/A	N/A	Quantitative	N	Maximum expected bedrock acceleration	Y
PALO ALTO/ F. Herman	URM, pre-1976, pre-1936, TU	2000 focus on older commercial	325	Pass/Fail	Sanborn maps building permits, previous study, owners	N	N

Table 1
(continued)

PROCEDURE/ Source	Building Groups Targeted	Survey Area (Size, number of buildings, population)	Number of Hazardous Buildings Identified	Method: Pass/Fail, Subjective, Quantitative?	Supplemental Information Employed?	Explicit Earthquake Definition	Sketch or Photo?
OAKLAND/ Arnold, Eisner (1980, 1984)	URM, WF ND-RC	Approximately 2000, Oakland Central Business District	377 approximately	Subjective, no clear definition of seismically suspicious	Y Sanborn maps, building permit, previous study, assessors' files	N	Photo, building plan, sketch
MULTIHAZARD/ FEMA & Reitherman et al. (1984)	Essential facilities, definition left to local jurisidiction All types	About 10,000 buildings since 1975	Unknown	Quantitative	Maps, construction drawings	UBC zone	Y
NEW MADRID/ Allen & Hoshall (1983)	All	Six couties population 1 million, approximately 2,400 buildings	N/A	Subjective, damage states	FEMA data	Y M = 7.6 & M = 8.6 MMI used for damage estimate	N
OSA HOSPITAL/ (1982)	Hospitals, all types of construction	1077	100 in classes E & F "low survive index"	Subjective	Building plans	UBC zone	Unknown
LOS ANGELES/ (1978-79)	URM	Entire city population 3 million, 490 square miles	8,000 approximately	Pass/Fail	Y Sanborn maps assessors' files, previous studies	Not explicit (large Ep.)	2 photos per building, sketch

Table 1
(continued)

PROCEDURE/ Source	Building Groups Targeted	Survey Area (Size, number of buildings, population)	Number of Hazardous Buildings Identified	Method: Pass/Fail, Subjective, Quantitative?	Supplemental Information Employed?	Explicit Earthquake Definition	Sketch or Photo?
UNIVERSITY OF CALIFORNIA/ McClure (1984)	Area greater than 4,000 square feet, human occupancy	44,000 square feet, approximately 800 buildings	9,000 square feet of Poor or Very Poor	Subjective	Previous studies, design drawings	MMI > IX	Y
SANTA ROSA/ Myers (1981)	All types built before 1958	About 400 buildings since 1972	About 90% for further review	Subjective	Plans	N	Photos and sketches
LONG BEACH/ Wiggins and Moran (1971)	Pre-1934 type 1, 2, 3	Entire city, population 500,000	938	Quantitative	Y Sanborn	N for LB study Y for Wiggins method (maximum expected bedrock acceleration)	Y
NBS 61/ Culver et al. (1975)	SB, DF, SW, CSF, RF, CSW, MSW, WF, 11 building frame types	N/A	N/A	Subjective and Quantitative (Capacity Ratio Rating) Structure Structure rating vs. MMI's	Suggest use of original drawings or soil reports, Sanborn maps	UBC zone, MMI levels > V	Building elevations and site plan with adjacencies, Photo suggested

Table 2
STRUCTURAL ASPECTS

PROCEDURE/ Source	Age/Design Level/ Building Practice	State of Repair	Occupancy Factor Definition	Material Groups	Number of Stories/ Dimensions	Symmetrical LFRS	Member Propor-tions	Sudden Changes in Member Dimensions	Tension-only Bracing	Connections	Previous Earthquake Damage	Renovated
CITY OF REDLANDS/ Mel Green & Assoc. (1986)	Y	Y	Y	URM	Y	N	N	N	N	Y	N	Y
SAN FRANCISCO/ Frank Lew	Y	N	N	URM	Noted, from assessor file	N	N	N	N	N	N	N
ABAG/ J. Perkins et al. (1986)	N	N	Y noted for some	Concrete Steel Wood Masonry	Y	N	N	N	N	N	N	If available
STANFORD PROJECT/ JABEEC TR 81, Thurston et al (1986)	Y	Y	Y essential facility or large number of occupants, residential, commercial or industrial	Steel Concerete Masonry Wood	Y noted number and dimensions	Y	N	Y	Y	Y	Y	Y
LOW-RISE/ Wiggins and Taylor (1986)	Noted, implicit in some of rating criteria	Y	Noted	Concrete Steel Wood Masonry	Y	Y	N	N	Not explicit, noted inadequate or in-complete bracing	Y	Y noted unrepaired earthquake damage	N

Table 2
(continued)

PROCEDURE/ Source	Age/Design Level/ Building Practice	State of Repair	Occupancy Factor Definition	Material Groups	Number of Stories/ Dimensions	Symmetrical LFRS	Member Proportions	Sudden Changes in Member Dimensions	Tension-only Bracing	Connections	Previous Earthquake Damage	Renovated
PALO ALTO/ F. Herman	Y	Noted but not formally employed	Y (number persons)	URM, TU	Noted but not formally employed	N	N	N	N	N	N	N
OAKLAND/ Lagorio, Arnold Eisner (BSD, 1984)	Y	Noted but not formally employed	Noted importance of structure 17 use codes	URM, TU ND-RC, mixed	Noted	N	N	Noted	N	N	N	Noted
MULTIHAZARD/ FEMA & Reitherman et al. (1984)	Y	Y	Noted use	Many classes	Y	Strong beam, weak columns	N	N	Y	Roof/wall and anchor bolts	N	Y
NEW MADRID/ Allan & Hoshall (1983)	Y	N	Y	Steel Concrete Masonry Wood	Y	N	N	N	N	N	N	N
OSA HOSPITAL/ (1982)	Y Building code jurisdiction	Y	Y Noted building use, Not included in ranking	Concrete Steel Masonry Wood	Y	Y	N	Y	Y	N accessed from plans	Not sure	Y
LOS ANGELES/ (1978-1979)	Y	Noted cracks & mortar condition	Y Table 33A UBC	URM	Y	Noted	N	N	Noted from parapet program	N	Noted	Noted from parapet program

Table 2
(continued)

PROCEDURE/ Source	Age/Design Level/ Building Practice	State of Repair	Occupancy Factor Definition	Material Groups	Number of Stories/ Dimensions	Symmetrical LFRS	Member Propor-tiosn	Sudden Changes in Member Dimensions	Tension-only Bracing	Connections	Previous Earthquake Damage	Renovated
UNIVERSITY OF CALIFORNIA/ McClure (1984)	Y	Noted but not significant in ranking	N	Concrete Steel Wood Masonry	Number stories dimensions from plans	Y	Y	Y	Y, not much found	Sometimes	At a few campuses	Y
SANTA ROSA/ Myers (1981)	Y	Y	Noted but not included in decision	No formal groups defined All types examined	Y	Y	N	Y	Y	Y	Y	Y
LONG BEACH/ Wiggins and Moran (1971)	N	Y	N, noted but not formally employed	RC, S, W, URM, RM	Y	Y	N	N	N	N	Y i.e., state of repair noted	N
NBS 61/ Culver et al. (1975)	Y noted but not formally employed employed	Y evidence of past damage repair noted	N noted but not formally employed	Concrete Masonry Steel Wood	Noted	Y	N	N	N	Y, if possible	N	Date noted

Table 3
CONFIGURATION ASPECTS

PROCEDURE/ Source	Soft Story	Plan Irregularity	Vertical Irregularity and Variation in Stiffness	Excessive Openings	Aspect (Vertical or Horizontal)	Corner Building
CITY OF REDLANDS/ Mel Green & Assoc. (1986)	N	N	N	N	N	Y can be inferred from site location sketch
SAN FRANCISCO/ Frank Lew	Noted	Noted	Noted	N	N	N
ABAG/ J. Perkins et. al. (1986)	Y	Y	Y	Y	Y	N
STANFORD PROJECT/ JABEEC TR 81, Thurston et al. (1986)	Y	Y	Y	Noted	Y	N
LOW-RISE/ Wiggins and Taylor (1986)	Y	Y	Y	Y	Y	N
PALO ALTO/ F. Herman	N	N	N	N	N	N
OAKLAND/ Arnold, Eisner (1984)	Y	Y	Y	Y	N	N

Table 3
(continued)

PROCEDURE/ Source	Soft Story	Plan Irregularity	Vertical Irregularity and Variation in Stiffness	Excessive Openings	Aspect (Vertical or Horizontal)	Corner Building
MULTIHAZARD/ FEMA & Reitherman et al. (1984)	Y	Y	Y	Y large door width open side	N	N
NEW MADRID/ Allen & Hoshall (1983)	N	N	N	N	N	N
OSA HOSPITAL/ (1982)	Y	Y	Y	Y percent openings noted	Y	N
LOS ANGELES/ (1978-79)	Not specific percent openings	Y	Y	Y percent openings noted	N	N
UNIVERSITY OF CALIFORNIA/ McClure (1984)	Y	Y	Y	Y	Y	N/A
SANTA ROSA/ Myers (1981)	Y	Y	Y	Y	Y	Y
LONG BEACH/ Wiggins and Moran (1971)	N	Y	Y	Y	Y	N
NBS 61/ Culver et al. (1975)	Y, noted	N	Y, Noted	Y, noted	N	Street sides noted

Table 4
SITE AND NON-STRUCTURAL ASPECTS

	SITE RELATED				NON-STRUCTURAL		
PROCEDURE/ Source	Pounding	Neighboring Building Collapse	Soil Conditions	Potential for Other Geohazards	Infill Walls	Interior Partitions	Cornices, Overhang Parapets, Chimneys
CITY OF REDLANDS/ Mel Green & Assoc. (1986)	Noted abutting buildings	Noted abutting buildings	N	N	N	Noted type	Y cornice parapet chimney signs ornament
SAN FRANCISCO/ Frank Lew	N	N	N	N	N	N	Noted
ABAG/ J. Perkins et al. (1986)	N	N	Not explicit, used map overlay	Not explicit, used map overlay	N	N	N
STANFORD PROJECT/ JABEEC TR 81, Thurston et al. (1986)	Y	Y, noted	Y, noted	Y	Y	Y	Y
LOW-RISE/ Wiggins and Taylor (1986)	N	Y Neighboring overhang collapse	Y	N	Y	Y	Y
PALO ALTO/ F. Herman	N	N	N	N	N	N	N

Table 4
(continued)

PROCEDURE/ Source	SITE RELATED				NON-STRUCTURAL		
	Pounding	Neighboring Building Collapse	Soil Conditions	Potential for Other Geohazards	Infill Walls	Interior Partitions	Cornices, Overhang Parapets, Chimneys
OAKLAND/ Arnold, Eisner (1980, 1984)	N	N	N	N	Noted	N	Noted
MULTIHAZARD/ FEMA & Reitherman et al. (1984)	N	N	Y Soft or hard	Landslide liquefaction Settlement Surface faulting	Y noted	N	Braced or unbraced or not present
NEW MADRID/ Allen & Hoshall (1983)	N	N	Y	Liquefaction	N	N	Y
OSA HOSPITAL/ (1982)	Noted distance to nearest building	Noted distance to nearest building	N	Liquefaction Landslide Alquist-Priolo seismic zone	N	Y noted URM partitions	N
LOS ANGELES/ (1978-79)	N	N	N	N	N	Y	Y, also from previous parapet program
UNIVERSITY OF CALIFORNIA/ McClure (1984)	Not a problem	N	N	Y Surface faulting in a few locations	N	Y	Y, noted but not significant in ranking

Table 4
(continued)

PROCEDURE/ Source	SITE RELATED				NON-STRUCTURAL		
	Pounding	Neighboring Building Collapse	Soil Conditions	Potential for Other Geohazards	Infill Walls	Interior Partitions	Cornices, Overhang Parapets, Chimneys
SANTA ROSA/ Myers (1981)	Y	N	Not explicit, all on alluvial fill	Not explicit, no potential for liquefaction or surface faulting	Y	Y	Y
LONG BEACH/ Wiggins and Moran (1971)	Y	Y	Y	N	Y	Y	Y
NBS 61/ Culver et al. (1975)	Y, noted	Proximity to adjacent buildings noted, separation joints noted	Proximity to adjacent buildings noted	Y Fault rupture liquefaction (implicit fault location noted)	Y, noted and rated	Y, noted and rated	Y, noted and rated

Table 5
PERSONNEL ASPECTS

PROCEDURE/ Source	Survey personnel Approximate person-hours per building	Local Building Officials	Professional Engineers	Registered Architects	Building Owners	Emergency Managers	Interested Citizens
CITY OF REDLANDS/ Mel Green & Assoc. (1986)	Not available	Y	Y	Y	N	N	N
SAN FRANCISCO/ Frank Lew	15 min per building	Y	Y	Y	N	N	N
ABAG/ J. Perkins	5 min per building, Very little information noted	Y	Y	Y	Y	Y	N
STANFORD PROJECT/ JABEEC TR 81, Thurston et al. (1986)	Experienced structural engineer	Y	Y	Y	N	N	N
LOW-RISE/ Wiggins and Taylor (1986)		Y	Y	Y	N	N	N
PALO ALTO/ F. Herman	15 min per building	Y	Y	Y	Y	Y	N

Table 5
(continued)

PROCEDURE/ Source	Survey personnel Approximate person-hours per building	Local Building Officials	Professional Engineers	Registered Architects	Building Owners	Emergency Managers	Interested Citizens
OAKLAND/ Arnold, Eisner (1980, 1984)	20 min per building	Y	Y	Y	N	N	N
MULTIHAZARD/ FEMA & Reitherman et al. (1984)	1 hour to 3 days per building	Y	Y	Y	N	Y	N
NEW MADRID/ Allen & Hoshall (1983)		N	Y	N	N	N	N
OSA HOSPITAL/ (1982)	1-2 days per building	N	Y	Y	N	N	N
LOS ANGELES (1978-79)	40 min per building	Y	Y	Y	N	Y	N
UNIVERSITY OF CALIFORNIA/ McClure (1984)	20 min per building	N	Y	N	N	N	N
SANTA ROSA/ Myers (1981)	1/2 day ($500) per building	Y	Y	Y	N	N	N
LONG BEACH/ Wiggins and Moran (1971)	Professional engineer	N	Y	N	N	N	N

Table 5
(continued)

PROCEDURE/ Source	Survey personnel Approximate person-hours per building	Local Building Officials	Professional Engineers	Registered Architects	Building Owners	Emergency Managers	Interested Citizens
NBS 61/ Culver et al. (1975)	1 hour per building	Y	Y	Y	N	N	N